Providing 1 lydrogen Maser Timing Stability to Orbiting VJ JBI Radio Telescope Observations by Post-Measurement Compensation of 1 inked Frequency Standard imperfections

J ames C. Springett
NeoComm Systems, inc.
2670 Orange Avenue
La Crescenta, CA 91214
(81 8) 957-5595

Abstract

Orbiting VLBI (OVLBI) astronomical observations are based upon measurements acquired simultaneously from ground-based and Earth-orbiting radio telescopes. By the mid 1990's, two orbiting VLBI observatories, Russia's *Radioastron*, and Japan's *VSOP*, will augment the worldwide VLBI network, providing baselines to Earth radio telescopes as large as 80,000 km. The challenge for OVLBI is to effectuate space to ground radio telescope data cross-correlation (the observation) to a level of integrity currently achieved between ground radio telescopes. But, VLBI radio telescopes require ultra-stable frequency and timing references in order that long term observations may be made without serious cross-correlation loss due to frequency source drift and phase noise. For this reason, such instruments make use of hydrogen maser frequency standards. Unfortunately, space-qualified hydrogen maser oscillators are currently not available for use on OVLBI satellites. Thus, the necessary long-term stability needed by the orbiting radio telescope may only be obtained by microwave uplinking a *ground-based* hydrogen maser derived frequency to the satellite. Although the idea of uplinking the frequency standard intrinsically seems simple, there are many "contaminations" which degrade both the long and short term stability of the transmitted reference. Factors which corrupt frequency and timing accuracy include additive radio and electronic circuit thermal noise, slow or systematic phase migration due to changes of electronic circuit temporal operating conditions (especially temperature), ionosphere and troposphere induced scintillation's, residual Doppler-incited components, and microwave signal multi path propagation, What is important, though, is to realize that ultimate stability does not have to be achieved in real-time. Instead, information needed to produce a high degree of coherence in the subsequent cross-correlation operation may be derived from a two-way coherent radio link, recorded, and later introduced as compensations adjunct to the VLBI correlation process. Accordingly, this paper examines the technique for stable frequency/time transfer within the OVLBI system, together with a critique of the types of link degradation components which must be compensated, and the figures of merit known as coherence factors.

(336 words)